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SOUTHWESTERN
RANGE & SHEEP BREEDING LABORATORY
FORT WINGATE, NEW MEXICO

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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
COOPERATING WITH THE
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS
AND THE
NEW MEXICO AGRICULTURAL EXPERIMENT STATION

1955-56 19 REPORT

THIS REPORT OF RESEARCH PROJECTS NOT YET COMPLETED IS INTENDED FOR THE USE OF ADMINISTRATIVE LEADERS AND WORKERS IN THIS OR RELATED FIELDS OF RESEARCH, AND NOT FOR GENERAL DISTRIBUTION.

ROSTER OF PERSONNEL

Name	Title	Date entered on duty	Duties
Stanley L. Smith	Animal Husbandman	Jul. 23, 1952	Director
George M. Sidwell [1]	Animal Husbandman	Dec. 1, 1946	Genetics
Gordon L. Jessup, Jr.	Animal Husbandman	Mar. 17, 1952	Sheep Investigations
Vern B. Swanson [2]	Animal Husbandman	Apr. 10, 1951	Sheep Management
Alison S. Dodge	Clerk-Stenographer	June 3, 1951	Clerical
Glenn C. Perkins	Farm Foreman	Sept. 24, 1954	Operations
Jimmie Gleason	Maintenance Man	Apr. 1, 1942	Maintenance
Fred Deschene	Labor Leader	Oct. 2, 1947	Camp Tender
Homer Dick [3]	Laborer	Apr. 7, 1953	Miscellaneous
Calvin Gleason	Laborer	Sept. 4, 1956	Miscellaneous
Sam Martinez	Animal Caretaker	Apr. 9, 1956	Sheepherder

1 Dr. George M. Sidwell is stationed at the New Mexico Agricultural Experiment Station, State College, New Mexico, where he is engaged in sheep breeding research of interest to both the New Mexico Station and the Sheep Breeding Laboratory. He also serves to coordinate the activities in sheep breeding research of the two institutions.

2 Resigned January 28, 1956

3 Terminated September 1, 1956

OBJECTIVE

The primary purpose of this laboratory is the development of a type of sheep most suited for the range conditions of the Southwest. In developing such an animal it has been the policy to employ basic breeding methods that can be used by other sheepmen of this area. With this objective in mind, selections have been based on body weight, production records of both lamb and wool, adaptability, yield of wool, and its suitability for handweaving and commerical manufacture. By selection of breeding animals displaying the best combination of these traits, it will be possible to produce an animal most suited for the economic requirements of the Navajo Indians and other sheepmen of the southwest.

OUTLINE OF RESEARCH PROGRAM

In order to achieve the above objective, the research program of the Southwestern Range and Sheep Breeding Laboratory is broken down into four research projects. The division of these four projects provides the optimum utilization of the animals and, at the same time, returns a maximum of records and data to be used in selection and improvement programs. The four projects at Fort Wingate are as follows:

1. Improvement of Navajo sheep by linebreeding and selection within the Navajo strain.

2. Improvement of finewool sheep under Southwestern conditions.

3. Improvement of coarsewool sheep for the production of wool suitable for Navajo hand weaving.

4. Investigations of wool for the improvement of Navajo, Navajo crossbred, Targhee and Targhee crossbred sheep under Southwestern range conditions.

These projects are carried out under the United States Department of Agriculture Work Projects ARS-b-2-1, Sheep Breeding Investigations, and ARS-b-2-1, Investigations of Wool and Other Animal Fibers.

(NOTE: When reference is made to the above projects in the following sections of this report, only the number preceding the project title will be used.)

PUBLICATIONS

The following papers have been published since the establishment of the Southwestern Range and Sheep Breeding Laboratory:

1. The Navajo Sheep Industry and Needs for Its Improvement:
   J. M. Cooper, The Sheep Breeder, May 1939.

2. The Sheep Industry of Indians in the Southwest:
   J. M. Cooper and Dewey Dismuke, Indians at Work, August, 1939.

3. Breeding for Adaptability to Local Conditions, with Special Reference to Sheep on the Navajo Indian Reservation:
   J. M. Cooper, American Society of Animal Production, 1939.

4. Improvement of the Navajo Sheep:
   Cecil T. Blunn, Journal of Heredity, March 1940.

5. Breeding for Quality Wool:
   James O. Grandstaff, The National Wool Grower, July 1940.

6. A Rapid Method for Projecting and Measuring Cross Sections of Wool Fibers:
   James O. Grandstaff and Walter L. Hodde, Circular No. 590, U. S. Department of Agriculture, December 1940.

7. Evaluating Fleece Characteristics of Navajo Sheep from a Breeding Standpoint:
   James O. Grandstaff, Rayon Textile Monthly, October-November 1941.

8. Wool Characteristics in Relation to Navajo Weaving:
   James O. Grandstaff, Technical Bulletin No. 790, U. S. Department of Agriculture, January 1942.

9. Characteristics and Production of Old-Type Navajo Sheep:
   Cecil T. Blunn, Journal of Heredity, May 1943.

10. The Influence of Seasonal Differences on the Growth of Navajo Lambs:
    Cecil T. Blunn, Journal of Animal Science, February 1944.

11. A Preliminary Report on the Post-Natal development of the Fiber Characteristics of the Fleeces of Navajo Sheep:
    James O. Grandstaff and Cecil T. Blunn, Journal of Animal Science, May 1944.

12. Comparison of the Yields of Side Samples from Weanling and Yearling Sheep:
    Cecil T. Blunn and James O. Grandstaff, Journal of Animal Science, May 1945.

13. Yearly Differences in G rowth of Navajo and Crossbred Ewe Lambs:
Cecil T. Blunn, Journal of Animal Science, August 1945.

14. Evaluating Fleece Quality of Navajo Sheep from Small Samples:
James O. Grandstaff and Cecil T. Blunn, Journal of Agricultural Research, September 1945.

15. Improvement of Wool for Navajo Hand Weaving:
James O. Grandstaff and Cecil T. Blunn, Indians at Work, March 1945.

16. Relation of Kemp and Other Medullated Fibers to Age in the Fleeces of Navajo and Crossbred Lambs:
James O. Grandstaff and Harold W. Wolf, Journal of Animal Science, May 1947.

17. Comparison of Corriedale x Navajo and Romney x Navajo Crosses:
James O. Grandstaff, Journal of Animal Science, November 1948.

18. Size of Lambs at Weaning as a Permanent Characteristic of Navajo Ewes:
George M. Sidwell and James O. Grandstaff, Journal of Animal Science, August 1949.

19. Adaptation of Livestock to New Environments:
James O. Grandstaff, for publication in Proc. United Nations Scientific Conference on Conservation and Utilization of Resources, Lake Success, New York, 1949.

20. Fertility and Reproduction in Sheep in Relation to Breeding and Environment:
James O. Grandstaff, presented at International Symposium on High Altitude Biology held at Lima, Peru, South America, November 23-30, 1949.

21. Genetic and Environmental Factors Affecting Staple Length in Navajo and Navajo Crossbred Weanling Lambs:
George M. Sidwell, James O. Grandstaff and Donald A. Price, Journal of Animal Science, February 1951.

22. Lamb Production of Navajo Ewes Bred to Columbia and Romney Rams, and Navajo Crossbred Ewes Bred to Lincoln and Cotswold Rams:
Donald A. Price, James O. Grandstaff and George M. Sidwell, Journal of Animal Science, February 1951.

23. Genetic and Environmental Factors Affecting Type and Condition in Navajo and Navajo Crossbred Weanling Lambs:
George M. Sidwell, Donald A. Price and James O. Grandstaff, Journal of Animal Science, May 1951.

24. Effects of Some Genetic and Environmental Factors on Yearling Traits of Navajo and Navajo Crossbred Ewes:
Donald A. Price, George M. Sidwell and James O. Grandstaff, Journal of Animal Science, November 1953.

25. Some Aspects of Twin Versus Single Lambs of Navajo and Navajo Crossbred Ewes:
George M. Sidwell, Journal of Animal Science, February 1956.

26. Estimation of Clean Fleece Weight from Small Side Samples and from Wool Density, Body Weight, Staple Length and Grease Fleece Weight:
George M. Sidwell, Gordon L. Jessup, Jr. and W. D. McFadden, Journal of Animal Science, February 1956.

27. Some Factors Influencing Fiber Diameter in Yearling Ewe Fleeces.
George M. Sidwell, Western Section Meetings of the American Society of Animal Production, Reno, Nevada, July 16-18, 1956.

SUMMARY OF PRECIPITATION

Month	Fort Wingate				El Morro		
	Average 1864-1911	Average 1938-1954	1955	1956	Normal	1955	1956
January	.96	.91	.83	1.75	.93	1.19	2.77
February	1.42	.61	1.02	.35	.84	.51	.73
March	1.02	1.03	.10	.08	1.18	.11	.07
April	.98	.56	.48	.41	.60	.26	.49
May	.58	.61	.64	.80	.41	.40	.59
June	.69	.53	.51	.30	.53	.90	.38
July	2.34	1.81	2.91	2.60	1.80	4.18	1.49
August	2.31	2.04	3.07	.54	2.76	3.29	1.23
September	1.37	1.22	.00	.03	1.46	.03	.07
October	1.05	1.02	.00	.74	1.01	.15	.61
November	.76	.68	.40	.23	.52	.38	.12
December	.97	.98	1.30	.29	1.03	.80	.17

The above table summarizes the precipitation at Fort Wingate and El Morro, New Mexico. The El Morro data is presented because the ewes and lambs are grazed on the El Morro range for a large part of the year and because there are sometimes appreciable differences in the amounts of precipitation between the two locations. Data at Fort Wingate from 1938 to the present have been compiled from Station records: all other data have been secured from U. S. Weather Bureau reports.

WEATHER CONDITIONS

1955

Precipitation during 1955 remained below average in all climatological divisions throughout New Mexico. Total precipitation recorded at the Sheep Laboratory was 11.26 inches, and that recorded at El Morro amounted to 12.42 inches. Better than average moisture during the month of February was counteracted by high, drying winds during the months of March, April, May and into the early part of June. Precipitation during March was .10 inches, the lowest on record for this month, at the Laboratory, and no precipitation was recorded during September, and only a trace during October, 1955.

Temperatures were cooler than average for the first eight months of the year, with February being the seventh coldest February on record in New Mexico.

1956

Total precipitation recorded at the Sheep Laboratory for the year 1956 amounted to 8.12 inches: only one other year, (1950, with a total of 6.06 inches) has received less moisture since records began to be kept by the Laboratory, in 1938. The month of March hit a new low with only .08 inches precipitation recorded; July had the highest recorded precipitation, with 2.60 inches. Total precipitation recorded at El Morro was 8.50 inches.

On a statewide basis, there was less than 50 percent of the normal annual moisture and all comparative figures show 1956 to be the driest year in 65 years of weather records in New Mexico.

Annual mean temperatures were close to average, although there was a considerable month-to-month variation during the year.

SUMMARY OF YEARS' OPERATIONS

1955

Due to six previous years of below average rainfall, 1955 was a hard year on the laboratory sheep. A considerable number were lost, particularly of the aged ewes, who were not strong enough to survive on the meager amount of forage. Other losses were largely in ewes carrying lambs while in very poor condition. The usual spring rains typical of this area were lacking in 1955 and supplemental feeding was necessary to pull the herd through. The ewes were wintered on the range and had to be fed 43 percent cottonseed cake at the rate of one/fifth pound daily. After shearing in April, they were started on 70 percent pellets at one-half pound per head, daily. From February to May there was a loss of 116 head of breeding ewes, most of which can be attributed to the unusual decline in physical condition.

The breeding ewes bred at the laboratory were trucked to the El Morro range on January 7th, the end of a 31 day breeding season. Some moisture was received during February and March, but high, strong winds dried out the range rapidly and all grazing areas were in extremely dry condition.

During the second week of April, preparations for shearing were begun. Measurements for wool density and body weight were taken on all rams and the yearling and two-year-old ewes. Density was measured by the use of the Neale Density Meter, developed by P. E. Neale of the New Mexico College of Agriculture and Mechanic Arts. Wool samples for fiber diameter and length were taken from the side and thigh. Scores for face, outercoat, color, horns, jaw and belly covering were recorded for all rams and the yearling and two-year-old ewes. Shearing was begun the last week in April: this was later than usual due to the difficulty of obtaining a shearing crew. The drouth conditions prevailing over the Southwest have resulted in much dirt and sand pentration of fleece, which in turn causes slow shearing and rapid wearing of combs and clippers. Due to these facts, most shearing crews were behind schedule.

Lambing began immediately after shearing and continued until the early part of June. Lambing on the range did not begin until June and ended in July. Early in June, weights and scores for type and condition were taken for yearling and mature ewes and rams. During the same week, lambs were vaccinated for soremouth and bluetongue.

The lambs were weaned in September. During weaning, lamb weights and body scores were taken. From these weights and scores,

culling sheets were prepared and the actual culling was done in October. Immediately after culling, the culled lambs were sent to market. Mature rams and ewes culled were brought to the Laboratory and sold to individuals.

Semen testing of rams was begun in November and lasted for two and one-half weeks. Early in December, the fall body weights were taken and ewes and rams were pen branded to be cut into the various breeding pens. Breeding began in December and lasted for approximately 31 days.

1956

The year of 1956 began with heavy snowfalls, resulting in some much needed moisture. However, the snow also presented a problem in that the sheep could not obtain forage. Snow ranged from 15 to 24 inches deep on the El Morro range where the Laboratory flock was moved after breeding. Feed had to be hauled in on sleds to the sheep and tractors were used to break trails in the snow, so the sheep could get to the feed. During this crucial period, the sheep had only pinon pine needles to eat. Everything else was covered by snow. Many local ranchers cut pinon trees for the sheep, and supplemented this with hay. There was some discussion as to whether pine needles would cause abortion. This is a well known fact in cattle, but evidently doesn't apply to sheep who eat them for a short time only, and not in excess.

In March, the Laboratory lost 12 yearling rams due to their eating poisoned hay. It was not possible to trace the source of the hay, but it was thought to contain whorled milkweed. In this area and most of the Southwest, there are several species of whorled milkweed. Among them is the Horsetail milkweed (Asclepia galioides) which has caused serious losses in sheep.

In April, body weights, density, scores and samples were taken. Shearing was begun April 25th. A Field Day was also held on April 25th and about 250 people attended. Dr. Sidwell of this Station, and Mr. J. R. Stauder, Wool Specialist of the New Mexico College of Agriculture and Mechanic Arts, gave illustrated talks showing the results obtainable from improved breeding programs. Shearing was completed May 2nd. Lambing began the same week. Supplemental feeding was necessary all spring due to the depleted range. A cube of 70 percent alfalfa was fed at the rate of one pound per head, daily. Body weights and scores for type and condition were recorded in June.

During July some badly needed rains fell. The Laboratory recorded 2.60 inches, which was above average and provided much needed water for grass and stock tanks.

Lambs were weaned in early September. Culling was done in September, also. This was earlier than usual, but thought advisable due to the lack of forage. By early culling, the Laboratory was able to ship some 300 head of cull lambs, thereby reducing the number grazing on the meager range supply.

During November, plans were discussed for reducing the sheep numbers at the Laboratory. This move had become necessary due to the prolonged drouth conditions. The breeding programs was continued as before, but each breeding group was reduced in size. Semen testing was done in November and breeding pens were assigned in early December. Breeding began December 5th, 1956 and ended January 7th, 1957. At the end of breeding, the flock was moved back to the El Morro range.

OUTLINE OF BREEDING PROGRAM

Type of Breeding and Group Number	Breeding of Rams	Breeding of Ewes	Number of Ewes Breeding Seasons 1954-55	1955-56
1	N	N	100	91
Coarsewool				
8 - 9	C_2 x Crossbreds * K x N	C_2 x Crossbreds	32	
10 - 11	R_1 x N	R_1 x N	29	
16	(K x N) x (C_2 x Crossbreds) (R_1 x N) x (L x Crossbreds)	(R_1 x N) x (L x Crossbreds) (K x N) x (C_2 x Crossbreds)	153	165
	and Reciprocal Crosses			
Finewool				
12	T	Crossbreds K x N R_1 x N	22	
13	T x Crossbreds	T x Crossbreds	93	100
Reservation				
20	Res	Res	83	101
21	R_2	Res	82	89
22	T	Res	74	77
23	(K x N) x (C_2 x Crossbreds) (R_1 x N) x (L x Crossbreds)	Res	76	92
Targhee				
25	T	T	100	65
		Totals:	844	780

OUTLINE OF BREEDING PROGRAM, CONTINUED

Code of Symbols for Breeds

C_1 - Corriedale	L - Lincoln	R_1 - Rambouillet
C_2 - Cotswold	N - Navajo	Res - Reservation
K - Columbia	R - Romney	T - Targhee

* NOTE: The term "crossbred" is used to designate the original crossbred ewes upon which all lines have been based. It consists of the following matings:

$$(C_1 \times N) \times (R_1 \times N)$$
$$(R_1 \times N) \times (C_1 \times N).$$

SUMMARY OF BREEDING PROGRAMS

1954 - 55

The Navajo ewes (Group 1) were reduced to 100 to be more completely in accord with the plan of work. This reduction from last year's 124 enabled us to cull more of the kempy, hairy, and light shearing ewes.

The coarsewool line (Groups 8-9, 10-11, and 16) was reduced from 343 to 214 ewes to make room for the purebred Targhee line. Because of reduced numbers, ewes previously in groups 8 and 9 were combined, and ewes of groups 10 and 11 were combined. Groups 8 and 9 are reciprocal crosses, as are groups 10 and 11.

Total number of ewes in the finewool line are approximately the same as last year.

Death losses and necessary culling have reduced to 315 the number of ewes in Groups 20, 21, 22, and 23. Ewe lambs saved from the 1954 lamb crop will restore these breeding groups to approximately full strength in 1955.

The purebred Targhee line is a new addition this year and has been designated as Group 25. One hundred ewes were divided at random, within age groups, into ten pens of ten ewes each. They were bred to eight inbred rams of Dubois selection and two inbred rams that were available at Fort Wingate. The breeding groups are associated with the research line projects as follows:

Breeding Groups	No. of Matings	Line Project
1	100	1
8-9, 10-11, 16	214	3
12, 13	115	4
20, 21, 22, 23	315	4
25	100	2
	Total - 844	

1955 - 56

Groups 8, 9, 10, and 11 were discontinued this year due to low numbers in each group and because replacements are not being produced. Offspring from groups 8 x 9 and 10 x 11 matings have been placed in Group 16. Group 16 is now sufficiently advanced to be considered a closed line. All future matings will be made from within the line. Numbers in this group have been reduced to 165 from the 1954 total of 214. This reduction is due partly to death losses of last winter and spring, partly to the elimination of the above-mentioned breeding groups, and partly to continued selection against those sheep having undesirable fleeces.

Group 12 has also been discontinued this year due to low numbers and lack of replacements. Offspring from Group 12 matings have gone into Group 13, and this group is also sufficiently advanced to be considered a closed line.

The Navajo line (Group 1) is slightly reduced from its goal of 100 ewes due to somewhat heavier than usual culling of aged ewes.

Groups 21, 22, and 23 (Reservation ewes) are low in numbers due to losses over the past two years when replacements were not available. The first lambs from these groups were added to the breeding flock this year, and have partially restored numbers in these three groups. Group 20 (the control group) has been completely restored in numbers by the addition of these first lambs to the breeding flock. All groups will be restored to full strength of 100 ewes each, as quickly as replacements become available.

The low numbers in the Targhee breeding group (Group 25) are due to heavy losses during the winter and spring.

Summary of Breeding Programs, Concluded.

The various breeding groups are associated with the research line projects as follows:

Breeding Group	No. of Matings	Line Project
1	91	1
13	100	2
20	101	2
21	89	2
22	77	2
25	65	2
16	165	3
23	92	3
	Total - 780	

Measurements, scoring, sampling and selections are done in the same manner each year, and if possible, on the same day, so all measurements will be comparable from year to year.

Body weights are recorded for mature and yearling sheep during the months of April, June and in December prior to breeding. The lambs are weighed at birth (May) and again in September at weaning time. These weaning weights are adjusted for days of age, at of dam, and type of rearing, whether single, twin, or a twin raised as a single. From these adjusted weaning weights, decisions are made for culling. Factors used in adjusting body weights at the Southwestern Range and Sheep Breeding Laboratory are as follows:

Type of Birth	Single - 4.70	Twin + 6.50	Twin Raised as Single - 1.80
Age of Dam			
(2) + 1.80	- 2.90	+ 8.30	0
(3) - 1.50	- 6.20	+ 5.00	- 3.30
(4-7) - 1.70	- 6.40	+ 4.80	- 3.50
(8) + 1.40	- 3.30	+ 7.90	- 0.40

Age of Weaning ± .37 lbs. per day.

An example of adjusting a lamb's weight can be illustrated thusly: a single lamb weighing 65.00 pounds, born of a 3-year-old ewe, and 4 days older than the average of 120 days, would be adjusted for weaning:

Actual weight ..... - 65.00 pounds
Born to a 3-year-old ewe, raised single - -6.20
Four days older than 120 days ..... - -1.48 (or - .37# per day)

Adjusted weaning weight - 57.32 pounds.

Other than weight, culling is based on scores for face covering, type, condition, outercoat, color, horn development, belly covering, and jaw structure, whether normal or abnormal. At weaning time when these scores are recorded, a small wool sample from the left side and thigh of each lamb is taken. These serve for length and fineness measurements. Lengths are adjusted to 120 days, and are considered in making selection at culling.

Measurement, Scoring, Sampling and Selection Techniques, continued.

Prior to shearing in April, the fleeces of the yearling and two-year-old ewes and all rams are sampled to determine staple length and fineness. Scores for all traits are made at this time. The staple lengths are measured to the nearest .1 cm. Fiber diameter is determined by cross-sectioning a sample from both side and thigh. The method employed here is the "Thick-section, Count Method". This provides information as to variability, percent of medullation and percent of kemp as well as mean fiber diameter.

Sampling of fleeces is done with an "Oster" clipper, a type of electric shears that allows clipping very close to the skin surface.

Culling of the mature ewes is done each fall. This culling is based on both lamb and wool production as well as physical defects, such as spoiled udders, sickness, and age.

Rams are selected for breeding on the basis of body and fleece scores and weights that are taken throughout the life of each ram. Just prior to breeding, all rams are semen tested. Any ram not producing high quality semen is not used in the breeding pens. At this station, cull ewes are used as a means of collecting the ram semen. This also provides a check on whether or not the ram will work. Semen is collected directly from the vagina by means of a glass tube and rubber suction bulb. Slow working rams can usually be induced to work by using ewes in heat or penning with several ewes.

Fleece weights are recorded at shearing time to the nearest .05 pound. The grease and clean fleece weights are adjusted to a constant age of 365 days and clean fleece weights to standard conditions of 12 percent moisture. In previous years. clean fleece weights have been determined by either whole fleece scouring or the scouring of small samples. Beginning in 1955, this station has cooperated with the New Mexico College of Agriculture and Mechanic Arts and Professor P. E. Neale of this college in providing fleeces for testing a machine to determine the clean wool content of a grease fleece. This work is discussed in the following section.

COOPERATION ON CLEAN WOOL MACHINE

In any program designed to increase wool production, the measure of actual clean wool produced by an individual animal is of the utmost importance. In the past, clean wool content or "yield" of a grease fleece has been determined by several accepted methods. These have been: (1.) estimation by an experienced wool handler, (2.) whole fleece scouring, and (3.) small sample scouring. While the first method is rapid, it is undesirable in that too much variation exists between estimates. Since this method is only an estimate, it can not be of much value to a research program based on accurate measurements. The second and third methods have proved to be rather slow and expensive. While fairly accurate, both methods must be performed by a skilled scouring crew or wool technologist and under ideal conditions. A slight change in scouring conditions, such as water temperature or amounts of soap and soda solution, can vary the results so that the entire process is worthless.

In view of these facts, Professor P. E. Neale of the New Mexico College of Agriculture and Mechanic Arts, has developed a machine to determine rapidly and accurately the clean wool content of a fleece. In order to obtain an accurate measure of yield for the yearling and mature ram fleeces produced at the Southwestern Range and Sheep Breeding Laboratory and to Aid in the calibration of this machine, 133 fine wool fleeces and 64 coarse wool fleeces were measured by the machine and scoured whole for clean fleece weights.

The correlations between clean fleece weight and machine reading, grease fleece weight and machine reading, and between clean fleece weight and grease fleece weight were .94, .90 and .87, respectively, for the finewool fleeces. For the coarse-wool fleeces, correlations were .94, .95 and .97, respectively. These same correlations for a total of 595 fleeces representing all grades of wool were .94, .83 and .78.

Further study is being conducted on this machine and this station is presently using the machine for the collection of clean wool data. The high degree of accuracy indicated by the correlations between machine readings and clean fleece weights indicates that it can be used as a reliable measure in a wool improvement program.

RESEARCH PROJECT 1

IMPROVEMENT OF NAVAJO SHEEP BY LINEBREEDING AND SELECTION IN THE NAVAJO STRAIN

The improvement of Navajo sheep is of great importance in this particular area. The major portion of the Navajo Indian income depends on the productivity of this strain of sheep. By the improvement of the breed itself and the resulting increase in return of wool and lamb, much can be done for the economic status of the Navajo.

The Navajo sheep displays an unusual amount of hardiness, mothering ability, fertility, and adaptability to semi-arid conditions, such as prevail in the Southwest. With improvement of wool quality and quantity, and mutton conformation, this strain of sheep provides a valuable means of transporting these desirable characteristics to other breeds by crossbreeding.

Data on the characteristics and production of Navajo ewes and rams is presented in this section.

CHARACTERISTICS OF NAVAJO BREEDING RAMS

Number of rams used, age of the rams at lambing, and fleece characteristics of Navajo rams mated to Navajo ewes from 1947 to present is summarized in the following table. The data was taken on the rams at yearling age. Selection has been based largely on quality and quantity of wool, with some emphasis placed on conformation, body weight, condition and color.

Rams used in the latter four or five years have averaged a little lighter in fleece weights. This has been due to a slight emphasis on a finer fleece, and freedom from medullation and other undesirable fibers. This has resulted in a slight decrease in average staple length.

CHARACTERISTICS OF NAVAJO BREEDING RAMS

Year	No. of Rams	Age at Lambing (years)	Fleece Weights as Yearlings		Yearling Fiber Traits stSide		
			Grease (lbs.)	Clean (lbs.)	Grade*	Staple Length (cms.)	Medullated Fibers (percent)
1947	3	3.0	6.98	4.93	50s	17.2	1.1
1948	4	3.0	7.56	5.02	48s	18.4	.0
1949	4	4.0	7.15	4.86	48s	17.8	.0
1950	4	2.8	6.93	4.39	48s	13.9	1.8
1951	5	2.8	7.01	4.11	50s	13.1	.0
1952	5	3.4	6.04	3.50	50s	11.9	.5
1953	5	3.6	5.81	3.67	54s	11.2	.6
1954	5	2.8	5.34	3.20	54s	9.4	.6
1955	4	2.4	5.04	3.27	58s	9.2	.0
1956	3	2.2	5.37	3.59	50s	12.0	.0
Average	4	3.0	6.32	4.05	50s	13.4	0.5

* Grade based on ASTM Standards.

CHARACTERISTICS OF NAVAJO BREEDING EWES

Characteristics of Navajo ewes bred to Navajo rams are summarized in the following table. Averages for number of ewes, age at lambing, body weight, and fleece traits are presented for the years 1947 through 1956.

Selection practiced on the Navajo breeding ewes has tended to reduce slightly the grease and clean fleece weights. This is most likely due to emphasis being placed on freedome from kemp, hair and other undesirable fibers. It has resulted in a finer, moreuniform fleece of slightly shorter staple length. Part of the reduction in quantity of wool can be attributed to environmental causes. The drouth conditions under which these ewes have had to live, has no doubt effected production in the past few years. There has also been a tendency to select and use younger ewes.

							Yearling Fiber Traits at Side		
			Body Wt.	Fleece Weights as Yearling					Other
Year	No. of Ewes	Age at Lambing (years)	at 18 Months (lbs.)	Grease (lbs.)	Clean (lbs.)	Grade	Staple Length (cms.)	Kemp (per-cent)	Med. Fibers (percent)
1947	116	5.7	96.7	4.60	3.18	58s	9.5	0.9	1.7
1948	115	7.4	99.4	5.34	3.68	58s	9.0	0.6	0.6
1949	133	5.0	101.1	5.51	3.64	58s	10.0	0.3	0.8
1950	140	5.1	102.8	5.68	3.69	58s	10.2	0.2	1.2
1951	156	4.9	98.2	5.15	3.08	56s	11.1	0.0	1.5
1952	173	4.8	97.7	5.22	2.91	58s	10.9	0.1	1.6
1953	105	5.3	98.2	5.23	3.11	58s	10.4	0.1	1.7
1954	124	4.9	97.3	5.21	3.19	58s	10.5	0.1	1.1
1955	100	5.2	97.2	5.03	2.78	58s	9.9	0.0	0.6
1956	91	4.0	95.0	4.36	2.53	60s	9.6	0.0	0.4
Average	125	5.2	98.4	5.13	3.18	58s	10.1	0.2	1.1

* Grade based on ASTM Standards.

LAMB PRODUCTION OF NAVAJO MATINGS

The following table summarizes the lamb production of Navajo ewes mated to Navajo rams. Weights are adjusted to 120 days and corrected for type of birth and rearing of lamb and age of the dam.

Year	No. of Ewes Bred	Percent of Ewes Lambing	Percent of Lambs born of Ewes Bred	Percent of Lambs weaned of Ewes Bred	Percent of Lambs weaned of live Lambs born	Average weaning weight in Pounds	Pounds of Lamb per ewe Bred
1947	116	83.9	125.4	117.8	92.0	60.5	71.9
1948	115	78.9	128.5	103.3	80.4	57.3	64.4
1949	133	85.0	116.5	93.2	80.0	56.4	52.6
1950	140	61.4	78.3	68.1	87.0	42.4	28.9
1951	156	88.5	95.5	31.4	32.9	32.6	10.2
1952	173	82.1	104.0	99.4	95.5	59.5	59.1
1953	94	92.6	128.7	119.1	92.6	52.6	62.7
1954	124	83.9	102.4	100.0	97.6	52.2	51.7
1955	100	87.0	113.0	90.0	79.0	46.8	42.0
1956	91	95.6	106.5	98.9	92.7	55.5	54.9
1947-56 Average	1242	83.8	109.8	92.1	82.9	51.5	49.8

The percent of ewes lambing is based on the number of ewes bred and still present at lambing. This gives an indication of fertility and takes into account any post-breeding death losses. Fertility of both ewes and rams has an effect on this percentage. The percent of lambs born of ewes lambing is based on all lambs born, dead or alive, of ewes actually having lambs. This figure minus 100 gives the percent of ewes having twins. In comparing the years of 1955 and 1956, it will be noticed that a greater percent of ewes had twins. This is reflected in the percent of lambs weaned of ewes bred and percent of lambs weaned of live lambs born. The year of 1955 shows a higher percent of twins than 1956, but a resulting lower percent alive at weaning. The percentage of twins is obvious in the weaning weight and pounds of lamb per ewe bred. There is a noticeable decline in these figures for 1955. All of this, of course, cannot be attributed to twins alone. The environmental conditions must be considered. The year of 1955 could not be classed as anything but a dry year, with reduced feed on the range. The desirability of twins would seem to hinge on the amount of feed available.

FACE AND BODY SCORES OF NAVAJO WEANLING LAMBS

Face and body scores of Navajo weanling lambs are summarized in the following table. Data is presented for the years 1947 through 1956. These scores were not taken prior to 1947.

The Navajo weanling lambs are characterized by open faces, clean legs, and poor body type. They have a tendency to fatten slowly externlly because most of the fat is stored internlly. The body scores have remained farily uniform for the past ten years. This is probably due to emphasis being placed on wool quality and fleece characteristics. Some attention is of course paid to body weight and size, but the amount of gain made for these characteristics does not appear to be reflected in the scores presented in the following table.

Scores have been made by different committees each year, and since the committee's scoring standards vary somewhat from year to year, very little can be deduced from the scores. The main purpose served by scoring is to compare this group of lambs with other groups scored by the same committee for one year.

	RAM LAMBS				EWE LAMBS			
Year	No. of Lambs	Face Covering (score)	Type (score)	Condition (score)	No. of Lambs	Face Covering (score)	Type (score)	Condition (score)
1947	55	2.71	3.50	3.61	82	2.72	3.19	3.15
1948	71	2.83	3.10	2.88	61	2.76	3.04	2.73
1949	66	2.64	3.09	3.00	58	2.65	3.22	2.92
1950	54	2.44	3.36	3.38	40	2.33	3.23	4.02
1951	21	2.43	3.49	3.53	28	2.52	3.49	3.34
1952	90	2.10	3.68	3.74	82	2.03	3.12	3.09
1953	64	2.64	3.09	3.44	48	2.48	3.06	3.26
1954	60	2.52	3.08	3.11	64	2.59	3.12	3.34
1955	51	2.21	3.02	3.23	36	2.31	3.13	3.29
1956	46	2.22	3.08	3.12	44	2.17	3.20	3.07
1947-56 Average	578	2.47	3.24	3.40	543	2.45	3.18	3.22

FLEECE CHARACTERISTICS OF NAVAJO WEANLING LAMBS

Fleece characteristics of Navajo weanling lambs are summarized for the years 1947 through 1956 in the following table.

Selection against kemp and other medullated fiber has been rigidly practiced every year. While there has been noticeable progress in eliminating these undesirable impurities, a few lambs are found each year with both kemp and medullation. Fiber diameter has fluctuated slightly. This is most likely due to environmental factors, such as amount of feed and weather conditions. Nutrition probably has the greatest bearing on diameter of fibers. Further study on this needs to be done, but would have to be under controlled feeding, rather than on range-fed lambs such as these.

Year	No. of Lambs Weaned	Fiber Diameter (microns)	Grade a/	Staple Length (cms.)	Kemp (percent)	Other Med. Fibers (percent)	Outer--coat (score) b/
1947	137	27.8	56s	4.7	0.0	0.4	-
1948	132	28.7	54s	3.4	0.3	3.2	3.78
1949	124	29.2	54s	4.1	0.2	2.1	3.18
1950	94	28.4	56s	3.3	0.3	4.3	3.36
1951	49	25.0	60s	4.2	0.0	3.5	3.27
1952	172	29.6	54s	3.6	0.7	6.1	3.51
1953	112	31.1	50s	3.4	0.0	2.4	2.14
1954	124	25.9	58s	3.6	0.9	0.9	2.81
1955	87	26.7	58s	4.3	0.2	1.2	2.41
1956	90	27.9	56s	4.7	0.0	0.8	1.55
1947-56 Averages	1121	28.0	56s	3.9	0.2	2.4	2.89

a/ Grade for all years converted to latest ASTM Standards.

b/ Scores for outer-coat not taken prior to 1948.

SELECTION PRACTICED ON NAVAJO WEANLING LAMBS

The selection differentials for the more important traits, the relative emphasis placed on each trait, and the expected genetic gain per generation are given in the following table. The percentage of lambs saved, by sex, is also given. Heritability estimates for each trait are included.

The selection differentials represent the average difference between the selected lambs and the entire group from which they came. The selection differentials for each trait are computed after corrections for environmental effects are made. The relative emphasis for each trait is computed by dividing the selection differential by the standard deviation for each trait.

Heritability estimates were obtained for Navajo and Navajo crossbred lambs for all traits except face covering score, color score, and outercoat score. The heritability for face covering score used to compute the expected genetic gain was obtained on range Targhee and Columbia lambs at the U.S. Sheep Experiment Station, Dubois, Idaho. Thus the expected genetic gain for face covering is accurate only to the extent that the Dubois estimate for heritability is representative of the lambs at this station.

The expected genetic gain per generation for each sex was obtained by multiplying the selection differential times the heritability estimate. The overall expected genetic gain per generation from selection practiced at weanling ages on both sexes was computed by averaging the expected genetic gains of both rams and ewes.

All positive signs for selection differentials indicate that the selected animals were superior to the unselected. This can be considered a genetic improvement. The negative signs for staple length are a result of selecting against those lambs with kemp or medullated fiber, resulting in shorter staple length. This is also influenced by selecting against animals having kemp and outercoat fibers.

At culling time, greatest emphasis is placed on weaning weight, staple length, and condition score. As can be seen in the following table, there is a small expected gain per generation for each trait. All of these are minute, except for weaning weight. This expected gain can be considered of importance.

SELECTION PRACTICED ON NAVAJO WEANLING LAMBS

Year	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer coat (score)	Percent Saved
1955		Heritability	21%	6%	30%	46%*	4%	11%	-	-	
	Rams	Selection Differential	5.15	-.09	.37	-.03	-.27	-.34	-.44	-.36	21%
		Relative Emphasis	.61	-.10	.16	-.02	-.60	-.80	-.55	-.46	
		Expected Genetic Gain	1.08	-.005	.11	-.01	-.01	-.04	-	-	
	Ewes	Selection Differential	2.13	.05	.59	-.20	-.12	-.18	-.12	-.37	61%
		Relative Emphasis	.28	.07	.26	-.30	-.20	-.30	-.096	-.31	
		Expected Genetic Gain	.45	.003	.17	-.09	-.004	-.02	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	.76	-.001	.14	-.05	-.007	-.03	-	-	
1956	Rams	Selection Differential	6.57	.11	.84	-.22	-.33	-.30	-.15	-.08	26%
		Relative Emphasis	.78	.142	.347	-.44	-.702	-.56	-.164	-.19	
		Expected Genetic Gain	1.38	.006	.252	-.10	-.013	-.033	-	-	
	Ewes	Selection Differential	.40	-.19	-.03	.02	.01	-.05	-.20	-.08	59%
		Relative Emphasis	.085	-.168	-.021	.066	.032	-.14	-.165	-.19	
		Expected Gentic Gain	.08	-.011	-.009	.009	.0004	-.005	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	.73	-.002	.121	-.045	.0063	.019	-	-	

* Heritability estimate for face covering score obtained for range Targhee and Columbia lambs at the U.S. Sheep Experiment Station, Dubois, Idaho.

BODY WEIGHTS AND SCORES OF NAVAJO YEARLING RAMS

Body weights and scores presented in the following table were taken during the month of June. The body weights in 1955 were above average and the majority of the other scores were better than the then year average. In 1956, the body weights declined somewhat. This is reflected in the type and condition scores, which also were below average. Since 1953 face scores have remained basically the same. Face covering is highly heritable (46 percent) and rapid gains can be made in improving this trait. It is fairly safe to assume that further progress in this trait will be very small, and the scores will continue to average around 1.60. Outer-coat scores are considerably better than the average, and while not as good as 1954, the 1955 and 1956 scores are well above the early scores for this trait taken in 1949-51.

Year	No. of Rams	Body Weight (lbs.)	Face Covering (score)	Type (score)	Condition (score)	Color (score)	Outer-coat * (score)
1947	2	115.0	2.25	3.17	3.09	1.50	-
1948	6	115.2	2.23	3.20	2.96	1.17	-
1949	14	112.3	2.33	2.89	2.64	1.36	2.24
1950	10	103.5	2.60	3.00	2.97	1.50	2.07
1951	9	90.9	2.58	2.67	3.13	1.00	3.60
1952	2	101.0	1.94	3.06	3.44	1.00	2.00
1953	8	112.0	1.27	2.90	2.68	1.50	2.63
1954	10	95.8	1.60	3.65	2.98	1.10	1.48
1955	11	111.0	1.68	2.74	3.15	1.09	1.85
1956	10	95.0	1.60	3.23	3.28	1.10	1.90
1947-56	82	105.2	2.00	3.05	3.03	1.23	2.22

* Scores for outercoat not taken prior to 1949.

FLEECE CHARACTERISTICS OF NAVAJO YEARLING RAMS

Year	No. of Rams	Fleece Weights Grease (lbs.)	Fleece Weights Clean (lbs.)	Fiber Diameter (microns)	Grade *	Fiber Traits at Side Staple Length (cms.)	Fiber Traits at Side Medullated Fibers (percent)
1947	2	7.18	4.70	33.6	46s	14.8	0.0
1948	6	6.65	3.88	32.0	48s	15.0	1.2
1949	14	6.43	4.30	28.8	54s	11.6	.1
1950	10	6.56	3.92	28.1	56s	12.6	.0
1951	9	5.82	3.32	30.0	54s	12.8	2.1
1952	2	5.39	3.07	29.1	54s	9.5	.0
1953	8	5.09	3.20	30.3	50s	10.4	.0
1954	10	3.95	2.72	23.6	62s	7.8	.0
1955	1	5.14	3.32	27.4	56s	10.0	0.1
1956	10	5.07	3.02	23.4	50s	10.3	0.0
1947-56	82	5.72	3.54	28.6	54s	11.4	0.3

* Grade based on ASTM Standards.

The above table is a summarization of the fleece characteristics of Navajo yearling rams for 1947 through 1956. Selection has been toward rams free of kemp, medullation, and coarse outercoat fibers. Progress has been made in reducing the percent of these fibers, as shown by the last column. Selection against these fibers has resulted in shorter staple lengths, and a lighter fleece weight.

BODY WEIGHTS AND SCORES OF NAVAJO YEARLING EWES

Body weights have declined somewhat in the last few years in comparison to early weights for Navajo yearling ewes. This is largely due to the depleted range conditions and prolonged drough. A gain has been made on face, color and outercoat score. Type and condition are affected by the lower body weights, and as a result do not show as much gain as other traits. Outercoat scores for 1955 are the best on record.

Year	No. of Ewes	Body Weights (lbs.)	Face Covering (score)	Type (score)	Condition (score)	Color (score)	Outercoat * (score)
1947	39	84.6	2.07	3.29	3.13	2.46	-
1948	75	86.8	2.58	2.97	2.68	1.32	-
1949	55	77.9	2.31	2.74	2.49	1.72	3.08
1950	46	75.7	2.43	2.84	2.91	1.30	3.05
1951	26	46.6	2.51	3.35	3.20	1.88	3.38
1952	11	75.4	1.92	3.06	3.22	2.39	3.91
1953	40	67.6	1.65	3.08	3.13	1.58	3.61
1954	27	73.1	1.93	3.24	3.91	1.26	2.50
1955	30	73.2	1.75	3.10	3.19	1.60	2.31
1956	21	68.8	1.77	3.10	3.29	1.76	2.60
1947-56	370	72.9	2.09	3.07	3.01	1.72	3.05

* Score for outercoat not taken prior to 1949.

[illegible]

FLEECE CHARACTERISTICS OF NAVAJO YEARLING EWES

Year	No. of Ewes	Fleece Weights Grease (lbs.)	Fleece Weights Clean (lbs.)	Fiber Diameter (microns)	Grade *	Fiber Traits at Side: Staple Length (cms.)	Fiber Traits at Side: Kemp (percent)	Fiber Traits at Side: Other Medullated Fibers (percent)
1947	39	5.14	4.00	31.6	50s	11.4	0.1	3.0
1948	75	6.19	3.82	28.1	56s	12.5	.2	1.1
1949	55	5.73	3.69	26.0	58s	10.5	.5	3.0
1950	46	6.38	3.38	26.1	58s	11.4	.1	1.6
1951	26	3.27	1.75	21.4	64s	10.2	.1	.9
1952	11	5.14	2.77	28.9	54s	9.1	.0	.7
1953	40	4.57	2.99	26.2	58s	10.6	.3	.8
1954	27	4.31	2.91	24.8	60s	8.8	.0	.1
1955	30	3.80	2.33	22.4	64s	10.0	.0	.0
1956	21	3.85	2.32	23.1	64s	9.6	.0	.0
1947-56	370	4.83	2.99	25.8	58s	10.4	.1	1.1

* Grade based on ASTM Standards.

Selection of yearling Navajo ewes has emphasized the elimination of kemp and medullation. As shown by the table above, marked progress has been made in this endeavor. However, the result has been a slight decrease in grease and clean fleece weights. The selection of finer fleeces has decreased the staple length somewhat.

RESEARCH PROJECT z

IMPROVEMENT OF FINEWOOL SHEEP UNDER SOUTHWESTERN CONDITIONS

This research project includes three distinct lines of breeding. Breeding groups 12 and 13 were developed from mating Targhee rams to ewes with fine wool selected from the crossbred groups. Breeding groups 20, 21, 22, and 23 are made up of average reservation ewes mated to average reservation rams, ram pasture rams, Targhee rams and coarse wool Laboratory rams, respectively. Group 25 is made up of a pure line of Targhee sheep.

The objective of this project is the development of a finewool sheep suited to this Southwestern area. Emphasis is placed on staple length, grade, freedom from kemp and medullation, adaptability, and lamb production. By selecting for these traits, it is hoped to develop an animal that will produce a maximum of wool, of a suitable quality, and produce lambs that will meet requirements for feed lot operations. The combination of these should provide a maximum return on sheep investments.

CHARACTERISTICS OF FINEWOOL BREEDING RAMS

The following table presents data on the finewool breeding rams used at this station in 1955 and 1956. The number of rams used, age, body weight, and yearling fleece traits are given.

Year and Breeding Group No.	No. of Rams	Age at Lambing (years)	Body Weight at Breeding (lbs.)	Yearling Fleece Weights Grease (lbs.)	Yearling Fleece Weights Clean (lbs.)	Grade*	Yearling Fiber Traits at Side Staple Length (cms.)
1955							
Group							
12	1	2.0	151.0	20.20	9.00	62s	10.7
13	3	2.6	165.3	8.85	4.84	60s	9.3
** 20	11	- Records not available			-	-	-
** 21	10	- Records not available			-	-	-
22	10	3.5	167.6	13.30	5.53	64s	9.1
23	10	2.2	139.6	6.64	4.24	58s	10.4
Total & Averages	45	2.5	155.8	12.24	5.90	60s	9.8
1956							
Group							
13	4	2.5	144.5	8.86	5.25	64s	9.7
20	10	2.0	123.2	5.50	2.68	70s	5.8
** 21	10	-	160.4	Records not available			-
22	10	4.3	173.9	15.20	6.05	62s	9.6
25	6	2.3	171.5	12.90	6.08	64s	8.6
Total & Averages	40	2.7	154.7	10.60	5.01	64s	8.4

* Grade based on ASTM Standards.

** Rams used in Group 20 and Group 21 for 1955, and Group 21 for 1956 were obtained from private breeders, and yearling records were not available.

CHARACTERISTICS OF FINEWOOL BREEDING EWES

Presented in the following table are the characteristics of the finewool breeding ewes used in 1955 and 1956. Data is presented as to number of ewes, age at lambing, body weight at 18 months of age, and yearling measurements for grease and clean fleece weights, grade, staple length, and percent medullation.

Measurements for most traits are near the eight year average, or slightly below it. The greatest improvement has been in the elimination of medullated fibers. There was only a minute amount of medullation in 1955, and none in 1956. This has resulted in a finer average grade, but has decreased the staple length. It is also reflected in the grease and clean fleece weights, which are slightly below average. Group 25, in the 1956 breeding program, is composed of Targhee ewes. These ewes were obtained from private breeders and the yearling records were not available.

Year and Breeding Group No.	No. of Ewes	Age at Lambing (years)	18 Mos. Body Weights (lbs.)	Yearling Fleece Weights: Grease (lbs.)	Yearling Fleece Weights: Clean (lbs.)	Grade*	Yearling Fiber Traits at Side: Staple Length (cms.)	Yearling Fiber Traits at Side: Med. Fibers (Percent)
1955 Group								
12	22	5.3	99.1	5.94	3.05	70s	9.5	0.7
13	93	3.4	100.1	6.19	2.70	70s	7.8	0.0
20	83	3.0	94.3	4.61	1.74	70s	4.8	0.0
21	82	3.0	95.8	4.85	1.79	70s	4.8	0.0
22	74	2.9	94.6	4.70	1.78	70s	4.8	0.0
23	77	3.0	93.9	4.86	1.80	70s	4.9	0.0
Total & Averages	431	3.4	96.3	5.19	2.14	70s	6.1	0.1
1956 Group								
13	100	3.8	99.7	5.89	2.74	70s	8.0	0.0
20	101	3.2	96.3	4.64	1.90	70s	5.0	0.0
21	89	3.4	96.0	4.78	1.94	70s	5.1	0.0
22	77	3.4	97.9	4.69	1.89	70s	5.1	0.0
** 25	65	-	-	-	-	-	-	-
Total & Averages	432	3.4	97.4	5.00	2.11	70s	5.8	0.0
1949-56	2001	4.0	100.3	6.01	2.85	64s	8.0	0.6

* Grade based on ASTM Standards.
** Records not available. These ewes purchased from private breeders.

PRODUCTION OF FINEWOOL MATINGS

The following table summarizes the lamb production of the finewool group. An average for the years 1949-56 is presented at the bottom of the table. As in prior tables, the percent of ewes lambing is based on the number present at lambing time. Percent of lambs born is based on actual births, whether dead or alive. Percent of lambs weaned weight is an indication of the milk production of the ewe and range conditions.

The 1955 production is not particularly outstanding, but rather alittle below the eight year average in all respects. The 1956 production is above average in all but one instance. The average weaning weight and pounds of lamb per ewe is exceptionally good.

Year and Breeding Group No.	No. of Ewes Bred	Percent of Ewes Lambing	Percent Lambs born of Ewes Lambing	Percent Lambs weaned of live Lambs Born	Percent Lambs weaned of Ewes Bred	Average weaning Weights in Pounds	Pounds of Lamb per Ewe Bred
1955 Group							
12	22	90.9	125.0	69.6	72.7	52.95	38.69
13	93	86.0	96.7	65.5	63.4	51.60	31.06
20	83	80.7	101.0	60.2	49.3	55.10	27.22
21	82	79.2	101.5	71.2	57.3	54.00	30.96
22	74	79.7	103.3	67.2	55.4	55.90	30.97
23	77	80.5	103.2	75.0	62.3	57.70	35.98
Total & Averages	431	82.8	105.1	68.1	60.0	54.54	32.48
1956 Group							
13	100	88.0	113.6	80.0	80.0	61.00	48.00
20	101	96.0	103.0	95.0	94.0	61.72	58.05
21	89	93.2	98.7	90.2	83.1	61.35	51.01
22	77	88.3	104.4	92.9	85.7	66.30	56.83
25	65	80.0	115.3	75.0	69.2	64.62	44.73
Total & Averages	432	89.1	107.0	86.6	82.4	62.99	51.76
1949-56	2001	86.5	123.0	76.8	79.7	55.20	46.00

FACE AND BODY SCORES OF FINEWOOL WEANLING LAMBS

Weaning scores for face covering, type, and condition are presented in the following table. An average for the eight year period, 1949-56, is summarized at the base of this table.

These scores are taken at weaning time when the lambs are about four months old. The scores for 1955 and 1956 are not outstanding, but are about the same as the eight year average. In both years, the ewe lambs scored better than the ram lambs for these three traits. This is also true for the 1949-1956 average.

Year and Breeding Group No.	No. of Lambs	Face Covering (score)	Type (score)	Condition (score)	No. of Lambs	Face Covering (score)	Type (score)	Condition (score)
1955								
Group								
12	9	2.70	2.70	2.84	7	2.76	2.62	2.80
13	19	2.96	2.72	2.95	38	2.78	2.78	2.87
20	24	3.62	2.93	2.91	17	3.25	3.11	2.87
21	24	3.73	2.99	2.88	23	2.94	2.74	2.70
22	16	3.45	2.45	2.60	24	3.06	2.70	2.69
23	20	3.04	2.48	2.57	28	3.09	2.59	2.63
Total & Averages	112	3.25	2.71	2.79	137	2.98	2.75	2.76
1956								
Group								
13	32	2.66	2.66	2.70	47	2.50	2.73	2.74
20	45	3.30	3.01	2.77	50	3.11	3.01	2.73
21	38	3.22	2.84	2.83	36	3.17	2.90	2.77
22	32	3.17	2.57	2.71	34	2.92	2.55	2.55
25	23	3.48	2.65	2.60	22	2.93	2.56	2.60
Total & Averages	170	3.16	2.74	2.72	189	2.92	2.75	2.67
1949-56	690	3.06	2.67	2.75	731	2.88	2.66	2.74

FLEECE CHARACTERISTICS OF FINEWOOL WEANLING LAMBS

The following table summarizes the fleece characteristics of the finewool weanling lambs. There is not much variation among groups, and only a slight difference between the years 1955 and 1956. Kemp fibers have been almost completely eliminated from the finewool lambs, and other medullated fibers have been greatly reduced. The scores for outercoat are better than the average for eight years, presented below. The selection against the coarse outercoat, kemp, and medullation has resulted in a finer grade of wool, slightly shorter staple length, but overall, a more valuable fleece.

Year and Breeding Group No.	No. of Lambs	Fiber Diameter (microns)	Grade*	Staple Length (cms.)	Kemp (percent)	Other Med. Fibers (percent)	Outer-coat (score)
1955							
Group							
12	17	25.35	60s	3.6	0.0	1.2	1.59
13	57	23.63	60s	3.6	0.0	1.2	1.34
20	41	22.68	62s	2.1	0.0	0.0	1.13
21	47	21.61	64s	2.5	0.0	0.1	1.08
22	40	23.51	62s	3.1	0.0	0.6	1.04
23	45	25.14	60s	3.3	0.0	1.4	1.21
Total & Averages	247	23.65	62s	3.0	0.0	0.7	1.23
1956							
Group							
13	80	25.21	60s	3.9	0.0	0.1	1.04
20	95	22.89	62s	2.2	0.0	0.2	1.14
21	74	21.81	64s	2.8	0.0	0.0	1.01
22	66	23.24	62s	2.9	0.0	0.1	1.02
25	45	25.13	62s	3.1	0.0	0.0	1.00
Total & Averages	360	23.25	62s	2.9	0.0	0.08	1.04
1949-56	1420	24.25	60s	3.0	0.08	0.62	1.37

* Grade based on ASTM Standards.

SELECTION PRACTICED ON FINEWOOL WEANLING LAMBS

The following table summarizes selection practiced on finewool weanling lambs in 1955 and 1956. The selection differential, relative emphasis, and the expected genetic gain are presented for rams and ewes by breeding groups. A positive selection differential for weaning weight and staple length is desireable and indicates a selection of animals outstanding and better than average for those traits. For fiber diameter, a negative selection differential indicates selection of finer fleeced individuals. This is desireable for the finewool groups. All other traits, which are measured by the scoring method, should have negative selection differentials when the better animals are selected. Because of the necessity of selecting highly outstanding animals in traits such as body weight and staple length, some sacrifice must be made for animals with perhaps lower face and body scores. This situation is reflected when a positive selection differentail is shown. As explained previously, the estimate of heritability per face covering was obtained on range Targhee and Columbia lambs at the U.S. Sheep Experiment Station at Dubois, Idaho. As a result, the expected genetic estimate applies to these lambs at this station.

In groups 21, 22, and 23 no rams are saved. The ewes saved from these groups are bred to rams obtained from outside sources. In 1956, a slightly higher percent of ewes from each group were saved in an attempt to bring the breeding groups up to sizes planned for. The extremely drouthy conditions the flock has operated under had forced a reduction in numbers.

SELECTION PRACTICED ON FINEWOOL WEANLING LAMBS

Year and Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat (score)	Percent Saved
		Heritability	21%	6%	30%	46%	4%	11%	-	-	
1955 Group 12	Rams	Selection Differential	+7.88	-.13	+.39	-.53	-.31	-.30	0	+.05	44%
		Relative Emphasis	.98	-.20	-.22	-.67	-.63	-.66	0	-.11	
		Expected Genetic Gain	1.65	.007	.117	-.24	-.012	-.033	-	-	
	Ewes	Selection Differential	-3.89	-1.23	-2.64	-.43	-.17	+.04	-.14	-.85	14%
		Relative Emphasis	- .98	-1.57	-1.43	-.66	-.43	-.16	-.37	-2.29	
		Expected Genetic Gain	- .81	- .07	- .07	-.19	-.006	+.004	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	+ .42	-.03	-.33	-.21	-.009	-.014	-	-	
Group 13	Rams	Selection Differential	+3.60	+.14	-.29	.00	-.29	-.23	+.07	-.24	57%
		Relative Emphasis	- .36	-.21	-.14	.00	-.48	-.39	-.07	-.54	
		Expected Genetic Gain	.75	.008	-.08	.00	-.01	-.02	-	-	
	Ewes	Selection Differential	+3.95	+.06	+.54	-.14	-.26	-.21	+.06	-.20	50%
		Relative Emphasis	- .47	-.12	-.011	-.26	-.47	-.42	-.27	-.35	
		Expected Genetic Gain	.82	.003	.16	-.06	-.01	-.02	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	+.78	+.005	+.04	-.03	-.01	-.02	-	-	

SELECTION PRACTICED ON FINEWOOL WEANLING LAMBS, CONT.

Year and Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer--coat (score)	Percent Saved
Group 20	Rams	Selection Differential	+ .35	-.16	-.62	±.12	-.01	0.0	-.33	+.06	62%
		Relative Emphasis	- .04	-.30	-.33	.16	-.02	0.0	-.45	.08	
		Expected Genetic Gain	.073	-.009	-.186	.055	-.0004	0.0	-	-	
	Ewes	----------		All Ewes Saved in Group 20							100%
Group 21	Rams	----------		No Rams Saved in Group 21							
	Ewes	Selection Differential	-.80	-.16	-.35	0.0	+.01	-.03	-.07	-.25	74%
		Relative Emphasis	-.09	-.31	-.29	0.0	.02	-.08	-.11	-.55	
		Expected Genetic Gain	-.168	-.009	-.105	0.0	.0004	-.003	-	-	
Group 22	Rams	----------		No Rams Saved in Group 22							
	Ewes	Selection Differential	-2.90	+.08	+.49	-.35	+.17	+.19	+.05	-.33	87%
		Relative Emphasis	- .38	.17	.25	-.32	.41	.57	.17	-.82	
		Expected Genetic Gain	- .60	.004	.147	-.16	.006	.020	-	-	
Group 23	Rams	----------		No Rams Saved in Group 23							
	Ewes	Selection Differential	+ .70	-.07	+.17	+.33	-.08	-.05	-.14	-.30	67%
		Relative Emphasis	.09	-.16	.024	.40	-.20	-.12	-.11	-.53	
		Expected Genetic Gain	.147	-.004	.051	.15	-.003	-.005	-	-	

SELECTION PRACTICED ON FINEWOOL WEANLING LAMBS, CONT.

Year and Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer--coat (score)	Percent Saved
		Heritability	21%	6%	30%	46%*	4%	11%	-	-	
1956 Group 13	Rams	Selection Differential	+3.05	+.10	+.39	-.08	-.23	-.15	-.28	+.03	53%
		Relative Emphasis	.34	.16	.20	-.13	-.40	-.31	-.31	.33	
		Expected Genetic Gain	.640	.006	.110	-.036	-.009	-.016	-	-	
	Ewes	Selection Differential	+2.31	+.50	+.51	-.03	-.18	-.18	-.12	-.01	73%
		Relative Emphasis	.33	.65	.26	-.05	-.35	-.367	-.15	-.09	
		Expected Genetic Gain	.480	.030	.150	-.013	-.007	-.019	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	.560	.018	.130	-.024	-.008	-.017	-	-	
Group 20	Rams	Selection Differential	-.05	-.04	-.26	+.01	+.06	+.04	-.08	-.04	33%
		Relative Emphasis	-.0016	-.093	-.464	.013	.138	.09	-.08	-.04	
		Expected Genetic Gain	-.010	-.002	-.078	.004	.002	.004	-	-	
	Ewes	----------		All Ewes Saved in Group 20							100%

SELECTION PRACTICED ON FINEWOOL WEANLING LAMBS, CONT.

Year and Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat (score)	Percent Saved
Group 21	Rams	----------	No Rams Saved in Group 21								
	Ewes	Selection Differentials	+ 4.85	+.03	- .03	+.01	- .28	- .24	-.68	.00	86%
		Relative Emphasis	- .63	-.05	- .01	-.01	- .43	- .41	-.81	.00	
		Expected Genetic Gain	1.01	.0018	- .009	.004	- .011	- .026	-	-	
Group 22	Rams	----------	No Rams Saved in Group 22								
	Ewes	Selection Differentials	+10.25	+.02	+ .45	-.06	- .60	- .55	+.09	.00	88%
		Relative Emphasis	- 1.01	-.04	- .29	-.11	-1.03	-1.03	-.16	.00	
		Expected Genetic Gain	2.15	.001	.135	-.027	- .024	- .060	-.	-	
Group 25	Rams	Selection Differentials	+ 9.00	+.14	+1.09	-.41	- .47	- .40	.00	.00	82%
		Relative Emphasis	- .66	-.22	- .40	-.64	- .68	- .62	.00	.00	
		Expected Genetic Gain	1.89	.008	.327	-.188	- .010	- .044	-	-	
	Ewes	Selection Differentials	+10.95	+.45	+2.66	-.01	- .81	- .50	.00	.00	91%
		Relative Emphasis	- .92	-.97	-1.08	-.21	-1.35	- .10	.00	.00	
		Expected Genetic Gain	2.29	.027	.798	-.004	- .032	- .055	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	2.09	.017	.562	-.096	- .025	- .049	-	-	

BODY WEIGHTS AND SCORES OF FINEWOOL YEARLING RAMS

Year and Breeding Group No.	No. of Rams	Body Weight (lbs.)	Type (score)	Condition (score)	Face Covering (score)	Color (score)	Outercoat (score)
1955							
Group							
12	2	131.0	2.00	1.83	2.83	1.00	1.00
13	11	114.2	2.18	2.05	2.41	1.00	1.00
20	15	100.5	2.80	2.63	3.06	1.20	1.00
21		No Rams Saved					
22		No Rams Saved					
23		No Rams Saved					
Total & Averages	28	115.2	2.32	2.17	2.76	1.06	1.00
1956							
Group							
13	8	103.6	2.38	2.31	2.04	1.00	1.00
20	13	94.8	3.05	2.81	2.99	1.08	1.00
21		No Rams Saved					
22		No Rams Saved					
25	9	100.4	2.26	2.13	3.35	1.00	1.00
Total & Averages	30	99.6	2.56	2.41	2.79	1.02	1.00
1955-56 Averages	58	107.4	2.44	2.29	2.78	1.04	1.00
1950-54 Average	122	110.8	2.39	2.18	2.54	1.14	1.23

The 1956 yearling finewool rams were slightly below the 1955 rams in all traits except color and outercoat scores. A great deal of improvement has been made in these two traits, and is clearly seen in comparing the scores for the period from 1950 through 1956. In all other respects, the finewool yearling rams for 1955-56 are about the same as those represented in the average for prior years. The 1955 rams are above average in body weight, while the 1956 yearling rams are several pounds below average.

FLEECE CHARACTERISTICS OF FINEWOOL YEARLING RAMS

Year and Breeding Group No.	No. of Rams	Fleece Weights Grease (lbs.)	Fleece Weights Clean (lbs.)	Fiber Diameter (microns)	Fiber Traits at Side Grade *	Fiber Traits at Side Staple Length (cms.)
1955 Group						
12	2	7.78	4.28	25.25	60s	8.0
13	11	7.29	3.96	21.91	64s	8.9
20	15	5.38	2.59	20.15	70s	5.6
21		No Rams Saved				
22		No Rams Saved				
23		No Rams Saved				
Total & Averages	42	6.81	3.61	22.43	64s	7.5
1956 Group						
13	11	7.87	4.11	20.91	70s	9.3
20	13	5.83	2.75	19.21	80s	5.4
21		No Rams Saved				
22		No Rams Saved				
25	9	6.48	3.27	18.29	80s	7.5
Total & Averages	33	6.72	3.37	19.47	80s	7.4
1955-56 Average	61	6.76	3.49	20.95	70s	7.45
1950-54 Average	64	8.22	4.38	24.00	62s	9.6

* Grade based on ASTM Standards.

The above table summarizes the fleece characteristics of finewool yearling rams. As noted in the preceding section, there are no rams saved from the number 21, 22, and 23 breeding groups. Rams for these groups are obtained from outside sources.

Rams in the 1955 breeding groups are slightly coarser in grade than those saved in 1956. As would be expected, their staple length is longer. This results in a heavier fleece weight and a little more clean wool. While it is not shown in the table, the shrinkage and yield of the 1955-56 finewool groups vary some three percent, with the coarser, longer 1955 groups being the lightest shrinking and heavier yielding. This can be calculated rapidly by dividing the clean weight by the grease weight. This gives the yield. The yield subtracted from 100 gives the shrinkage in percent.

While a difference of three percent in shrink or yield does not seem like a large amount, it can made a lot of difference in the monetary return on a clip. These two groups of rams both produce wool that would sell as "fine", one averaging 64s and the other 80s spinning count. If finewool were selling for $1.40 clean, the 1955 clip would be worth .742¢ per pound and the 1956 clip only .70¢ per grease pound. This difference of .042¢ per pound could mean a lot on a large clip- $42.00 per thousand pounds. These few figures indicat that it would be wise to select those animals producing a longer wool and heavier clean fleece of a slightly coarser grade, rather than striving to produce the top of the finewool class (such as 80s) and sacrificing length to obtain fineness. In the program at the Southwestern Range and Sheep Breeding Labortory it is sometimes necessary to select certain animals which diplay an unusual body size, indicating their adaptability to this area. In doing so we must at times reject an animal that might shear more wool, but be of a inferior size.

BODY WEIGHTS AND SCORES OF FINEWOOL YEARLING EWES

Year and Breeding Group No.	No. of Ewes	Body Weight (lbs.)	Type (score)	Condition (score)	Face Covering (score)	Color (score)	Outercoat (score)
1955 Group							
12	11	74.9	2.55	2.52	1.88	1.00	1.05
13	16	71.7	2.84	2.63	1.60	1.06	1.02
20	45	70.2	3.01	3.02	2.63	1.62	1.04
21	29	68.1	2.88	2.97	2.78	1.21	1.02
22	21	72.6	2.68	2.75	2.27	1.10	1.00
23	34	71.1	2.76	2.91	1.84	1.44	1.17
Total & Averages	156	71.4	2.78	2.80	2.16	1.23	1.05
1956 Group							
13	17	77.5	2.10	2.26	1.80	1.06	1.13
20	14	71.8	2.94	2.80	2.05	1.64	1.06
21	16	71.6	2.68	2.51	2.37	1.19	1.00
22	21	72.8	2.44	2.34	2.17	1.00	1.00
25	17	77.0	2.06	2.17	2.42	1.00	1.00
Total & Averages	85	74.1	2.44	2.41	2.16	1.17	1.03
1955-56 Averages	241	72.7	2.61	2.60	2.16	1.20	1.04
1950-54 Averages	184	76.8	2.34	2.22	2.29	1.19	1.43

The above table summarizes the body weights and scores of finewool yearling ewes for 1955 and 1956. On the average, the 1956 yearling ewes selected were superior to those of 1955. The average body weight for finewool yearling ewes in 1956 was three pounds heavier than those of 1955. In comparing general range conditions and moisture received, 1955 was a better year than 1956. The heavier weights in 1956 can be attributed to two causes. First, the gain made in body weights and scores was due to the progress being made from proper selection and culling over a period of years. If a program is worth using, such gains are to be expected. Secondly, in 1956 a reduction in numbers was necessary due to depleted range conditions. This afforded the opportunity to cull out

many mediocre animals that would have had to be kept if the same numbers were maintained. The 1956 yearling ewes kept, totaled only 85 head, as compared to 156 kept in 1955. This reduction allowed very rigid selection.

The 1955-56 groups were on the average slightly poorer than the 1950-54 groups for body weights, type, and condition. In face covering and outercoat scores, they were superior to the 5-year average. Constant rigid selection and the high percent of heritability (estimated 46 percent) for face covering is responsible for the gains made in these traits.

FLEECE CHARACTERISTICS OF FINEWOOL YEARLING EWES

Year and Breeding Group No.	No. of Ewes	Fleece Weights Grease (lbs.)	Fleece Weights Clean (lbs.)	Fiber Traits at Side: Fiber Diameter (microns)	Fiber Traits at Side: Grade *	Fiber Traits at Side: Staple Length (cms.)
1955 Group						
12 & 13	27	5.29	2.86	18.52	80s	8.48
20	45	4.68	2.07	18.53	80s	5.31
21	29	4.66	2.23	17.20	80s	6.04
22	21	4.87	2.34	18.07	80s	5.88
23	34	4.26	2.27	20.66	70s	7.05
Total & Averages	156	4.75	2.35	18.59	80s	6.55
1956 Group						
13	18	6.01	3.11	19.34	80s	8.05
20	14	4.98	2.02	17.91	80s	5.28
21	16	5.43	2.57	17.65	80s	7.11
22	21	5.46	2.63	18.81	80s	6.65
25	17	5.46	2.64	18.95	80s	7.20
Total & Averages	86	5.46	2.59	18.53	80s	6.85
1955-56 Average	242	5.10	2.47	18.56	80s	6.70
1950-54 Averages	184	6.51	2.97	20.70	70s	8.30

* Grade based on ASTM Standards.

The fleece characteristics of the finewool yearling ewes for 1955 and 1956 indicate that some progress has been made for fleece weights and clean yield. The 1956 finewool yearling ewes are heavier in clean and grease fleece weights, and longer in staple length than the 1955 groups. The grade is basically the same, both groups being of 80s spinning count. The increase is probably due to a larger bodied ewe being selected. The 1950-54 average is higher in grease weight and

staple length, but lower than 1955 and 1956 in clean wool or yield. The 1950-51 ewe averages show a greater staple length and slightly coarser spinning count of 70s. As explained in the preceding section, the reduction of numbers in 1956 allowed for more rigid selection and elimination of mediocre animals that would ordinarily have been retained to maintain herd numbers. It is interesting to note that the 1955-56 ewes producing 1.4 pounds less grease wool on the average than the ewes from 1950-54, still produced approximately 3 percent more clean wool. This was done even with a sacrifice of 1.6 centimeters of staple length and an increase in spinning count to 80s, which is usually greasier and has a higher shrinkage rate than 70s.

RESEARCH PROJECT 3

IMPROVEMENT OF COARSEWOOL SHEEP FOR THE PRODUCTION OF WOOL SUITABLE FOR NAVAJO HANDWEAVING

The objective of this project is the development of a coarsewool sheep that will produce a wool fitted to the needs of the Navajo Indian, and produce a good quality lamb suitable for feeding. A portion of the wool grown by the Navajo is used in hand weaving rugs and blankets. This wool should be in a grade range of 46 to 50s spinning count. The production of that quality wool on an animal adaptable to this environment is of the utmost importance to the welfare of the Navajo Indian. Selection has been placed primarily on those animals displaying hardiness, adaptability, body size, good staple length, and, of course, clean wool production.

CHARACTERISTICS OF COARSEWOOL BREEDING RAMS

Year and Breeding Group No.	No. of Rams	Age at Lambing (years)	Body Weight at Breeding (lbs.)	Yearling Fleece Weights Grease (lbs.)	Yearling Fleece Weights Clean (lbs.)	Yearling Fiber Traits at Side Grade*	Yearling Fiber Traits at Side Staple Length (cms.)	Yearling Fiber Traits at Side Med. Fibers (percent)
1955 Group								
8 & 9	1	5.0	192.0	9.20	3.96	48s	11.6	0
10 & 11	1	6.0	190.0	7.65	4.40	56s	12.5	0
16	5	3.2	168.2	8.32	5.33	54s	11.6	0
Total & Averages	7	4.7	183.4	8.14	4.42	52s	11.9	0
1956 Group								
16	6	2.0	134.0	7.99	5.48	54s	13.8	0
23	9	2.5	141.6	7.39	4.73	54s	11.7	0
Total & Averages	15	2.2	137.8	7.69	5.10	50s	12.7	0
1955-56 Average	22	3.5	160.6	7.91	4.76	54s	12.3	0
1950-54 Average	74	3.2	176.8	9.21	5.29	50s	12.1	.06

* Grade based on ASTM Standards.

The above table presents data as to the characteristics of coarsewool rams used at this station. It will be noticed that the rams of these groups are large and shear a large, light-shrinking fleece. The coarsewool fleeces from such rams are relatively free of grease and suint. However, being rather loose they tend to pick up a considerable amount of vegetable matter, which accounts for most of the shrinkage. The 1955 rams were larger than the 1956 group, shearing a heavier grease fleece, but less actual clean wool. The 1956 rams were better in staple length. Both groups were completely devoid of any medullated fibers, indicating considerable gain over coarsewool rams used in preceding years. Rams used in 1955 and 1956 were finer in grade than rams used from 1950 through 1954.

CHARACTERISTICS OF COARSEWOOL BREEDING EWES

Year Breeding Group No.	No. of Ewes	Age at Lambing (years)	18 mos. Body Weight (lbs.)	Yearling Fleece Weight Grease (lbs.)	Yearling Fleece Weight Clean (lbs.)	Grade *	Yearling Fiber Traits at Side Staple Length (cms.)	Yearling Fiber Traits at Side Med. Fibers (percent)
1955 Group								
8 & 9	31	6.33	103.4	7.73	3.94	62s	11.5	1.0
10 & 11	29	6.45	104.8	7.13	3.83	58s	10.9	0.3
16	153	3.16	99.7	5.52	3.21	60s	9.4	0.2
Total & Averages	213	5.31	102.6	6.79	3.66	60s	10.6	0.5
1956 Group								
16	165	3.58	101.1	5.41	3.20	62s	10.1	0.2
23	93	3.31	96.5	4.68	1.99	70s	5.6	0.01
Total & Averages	258	3.44	98.8	5.04	2.59	66s	7.8	0.10
1955-56 Average	471	4.37	100.7	5.91	3.12	62s	9.2	0.3
1950-54 Average	2307	3.90	104.6	7.08	4.07	58s	11.1	0.8

* Grade Based on ASTM Standards.

Number of ewes per group, age at lambing, body weight, and yearling fleece characteristics are presented in the above table for coarsewool breeding ewes.

Ewes used in these breeding groups are large bodied and long stapled. Selection for the past few years has been toward a finer fleece and the elimination of kemp and medullated fibers. Body weight and staple length have remained fairly constant through the years. Clean yield has decreased somewhat, and is probably due to the tendency to select finer fleeced ewes, having a greasier fleece.

LAMB PRODUCTION OF COARSEWOOL MATINGS

Year and Breeding Group No.	No. of Ewes Bred	Percent of Ewes Lambing	Percent Lambs Born of Ewes Lambing	Percent Lambs weaned of Live Lambs Born	Percent Lambs weaned of Ewes Bred	Average weaning weight in Pounds	Pounds of Lamb per Ewe Bred
1955 Group							
8 & 9	32	81.2	111.5	72.0	62.5	58.10	36.31
10 & 11	29	89.6	104.7	57.9	54.5	57.75	32.63
16	153	92.1	104.6	75.2	80.1	52.05	36.91
Total & Averages	214	87.6	106.9	68.4	65.7	55.96	35.25
1956 Group							
16	165	92.7	104.7	84.2	84.9	66.15	51.78
23	93	96.7	103.5	85.2	88.2	63.30	55.68
Total & Averages	258	94.7	104.1	84.7	86.5	64.72	53.78
1955-56 Averages	472	91.1	105.5	76.5	76.1	60.34	44.51
1937-56 Averages	8068	84.3	126.9	83.5	86.0	59.00	50.90

The above table summarizes lamb production of coarsewool ewes in Research Project 3 for 1955 and 1956. Also included is the average lamb production for the years 1937 through 1956.

The percent of ewes lambing was based on number of ewes bred, for the years 1937-51. Beginning in 1952 this figure is based on number of ewes still present at lambing time. The latter mthod gives a better indication of fertility by allowing for ewe death losses prior to lambing. Percent of lambs born of ewes lambing minus 100 gives the percentage of ewes having twins. From the years 1937-46 average weaning weight and pounds of lamb per ewe were based on wights taken at about 140 days of age and unadjusted for any enviromental factors. Beginning in 1947 weights are adjusted to 120 days and corrected for type of birth, rearing of lamb, and age of dam.

LAMB PRODUCTION OF COARSEWOOL MATINGS, CONT.

The 1956 coarsewool lamb production is well above that of 1955 in all respects except for percent of lambs born. This indicates less twins in 1956, which would be largely responsible for the better weaning weights and pounds of lamb per ewe.

FACE AND BODY SCORE OF COARSEWOOL WEANLING LAMBS

Year and Breeding Group No.	No. of Lambs	Face Covering (score)	Type (score)	Condition (score)	No. of Lambs	Covering (score)	Type (score)	Condition (score)
1955 Group								
8 & 9	11	2.96	2.73	2.84	14	2.40	2.57	2.92
10 & 11	12	2.58	2.26	2.64	9	2.56	2.67	2.89
16	83	2.85	2.90	3.15	70	2.51	2.85	3.01
Total & Averages	106	2.79	2.63	2.87	93	2.49	2.69	2.94
1956 Group								
16	65	2.59	2.65	2.83	65	2.50	2.80	2.80
23	35	2.91	2.62	2.65	40	2.74	2.77	2.73
Total & Averages	100	2.75	2.63	2.74	105	2.62	2.78	2.76
1955-56 Averages	206	2.77	2.63	2.80	198	2.55	2.73	2.85
1949-54 Average	1321	2.93	2.72	3.12	1288	2.80	2.75	3.00

A summarization of face and body scores for coarsewool weanling lambs is presented in the above table. In general the scores for later years are better than those of 1949-54. There is not much difference between sexes. The ewe lambs have a slightly better face score for each year presented. The 1949-54 average is pulled down considerably for condition due to extremely drouthy years in 1950 and 1951.

FLEECE CHARACTERISTICS OF COARSEWOOL WEANLING LAMBS

Year and Breeding Group No.	No. of Lambs	Fiber Diameter (microns)	Grade *	Staple Length (cms.)	Kemp (percent)	Other Med. Fibers (percent)	Outer--coat (score)
1955 Group							
8 & 9	26	28.90	54s	4.8	.0	5.5	2.38
10 & 11	21	27.69	56s	4.5	.0	6.5	2.10
16	153	27.93	56s	4.5	.4	3.2	2.24
Total & Averages	200	28.14	56s	4.6	.1	5.0	2.24
1956 Group							
16	130	29.05	54s	6.5	.0	1.1	1.54
23	75	27.39	56s	3.7	.0	.5	1.14
Total & Averages	205	28.22	56s	5.0	.0	.8	1.34
1955-56 Averages	405	28.18	56s	4.8	.05	2.9	1.79
1949-54 Averages	2608	28.30	56s	4.1	.13	2.2	2.47

* Grade based on ASTM Standards.

The fleece characteristics of coarsewool weanling lambs of Reasearch Project 3 are given above. These traits are measured at the side. The 1956 lambs are better than the 1955 lambs in all traits, particularly in a lower percent of medullated fibers and outercoat scores. The average for both years shows a gain in all traits over the 1949-54 lambs.

SELECTION PRACTICED ON COARSEWOOL WEANLING LAMBS

The selection differentials, relative emphasis and expected genetic gain per generation for weanling lambs in Research Project 3 are shown in the following table.

The most emphasis has been placed on weaning weight, body type, condition and outercoat scores. Selection against outercoat and medullation has resulted in some selection pressure against staple length.

Relative emphasis on each trait at weaning time is computed by multiplying the selection differential by the standard deviation for that trait. The expected genetic gain is figured by multiplying the selection differential by the heritability estimate. The expected genetic gain per generation is an average of the ewes and rams expected gain.

As explained previously a positive selection differential for weight and staple length is desirable, while a negative figure for the score traits, face, type, condition, color, and outercoat indicate superiority of the selected animals.

SELECTION PRACTICED ON COARSEWOOL WEANLING LAMBS

Year and Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat- (score)	Percent Saved
		Heritability	21%	6%	30%	46%	4%	11%	-	-	
1955 Group 8 & 9	Rams	Selection Differential	+9.74	+.40	+1.62	+.11	-.55	-.46	-.20	-.23	40%
		Relative Emphasis	.63	.63	.57	.22	-.78	-.53	-.47	-.45	
		Expected Genetic Gain	2.04	.024	.486	.050	-.022	-.050	-	-	
	Ewes	Selection Differential	+5.82	-.29	- .12	-.18	-.48	-.41	-.15	-.87	40%
		Relative Emphasis	.66	-.56	- .03	-.28	-.85	-.75	-.96	-.80	
		Expected Genetic Gain	1.22	-.017	- .036	-.082	-.019	-.045	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	1.63	.003	.225	.066	-.020	-.047	-	-	
Group 10 & 11	Rams	Selection Differential	+4.90	+.04	+ .82	-.34	-.17	-.02	-.33	+.11	33%
		Relative Emphasis	.66	.03	.31	-.69	-.98	-.03	-.47	.18	
		Expected Genetic Gain	1.02	.002	.246	-.156	-.006	-.002	-	-	
	Ewes	Selection Differential	+6.57	+.12	+ .10	+.39	-.43	-.35	-.33	-.44	66%
		Relative Emphasis	.41	.48	.05	.60	-.44	-.43	-.57	-.57	
		Expected Genetic Gain	1.37	.007	.030	.179	-.017	-.038	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	1.19	.005	.238	.011	-.011	-.042	-	-	

SELECTION PRACTICED ON COARSEWOOL WEANLING LAMBS, CONT.

Year and Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer-coat (score)	Percent Saved
		Heritability	21%	6%	30%	46%	4%	11%			
1955 Group 16	Rams	Selection Differential	+7.39	+.15	-.73	-.02	-.36	-.20	-.56	-.55	23%
		Relative Emphasis	.69	.16	-.33	-.04	-.58	-.40	-.53	-.53	
		Expected Genetic Gain	1.55	.009	-.219	-.009	-.014	-.022	-	-	
	Ewes	Selection Differential	+6.01	-.61	-.60	-.22	-.47	-.24	-.38	-.86	19%
		Relative Emphasis	.72	-.55	-.18	-.41	-.97	-.36	-.35	-.74	
		Expected Genetic Gain	1.26	-.036	-.180	-.101	-.018	-.026	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	1.41	-.013	-.199	-.105	-.016	-.024	-	-	
1956 Group 16	Rams	Selection Differential	+4.49	+.07	+.61	-.14	-.26	-.26	-.52	-.14	44%
		Relative Emphasis	.42	.06	.28	-.25	-.56	-.60	-.47	-.31	
		Expected Genetic Gain	.942	.004	.183	-.064	-.010	-.238	-	-	
	Ewes	Selection Differential	+1.47	+.26	+.46	-.05	-.12	-.14	-.10	-.08	69%
		Relative Emphasis	.21	.18	.16	-.08	-.28	-.33	-.11	-.02	
		Expected Genetic Gain	.308	.015	.138	-.023	-.004	-.015	-	-	
	Rams and Ewes	Expected Genetic Gain per Generation	.625	.009	.160	-.043	-.007	-.021	-	-	

SELECTION PRACTICED ON COARSEWOOL WEANLING LAMBS, CONT.

Year and Group No.	Sex		Weaning Weight (lbs.)	Staple Length (cms.)	Fiber Diameter (microns)	Face Covering (score)	Body Type (score)	Condition (score)	Color (score)	Outer--coat (score)	Percent Saved
		Heritability	21%	6%	30%	46%	4%	11%			
1956 Group 23	Rams	----------	No Rams Saved in Group 23								
	Ewes	Selection Differential	+3.35	-.12	+.50	+.04	-.20	-.09	-.22	-.11	80%
		Relative Emphasis	.36	-.16	.18	.07	-.43	-.20	-.20	-.13	
		Expected Genetic Gain	.703	-.007	.150	.018	-.008	.009	-	-	

BODY WEIGHTS AND SCORES OF COARSEWOOL YEARLING RAMS

Year and Breeding Group No.	No. of Rams	Body Weight (lbs.)	Type (score)	Condition (score)	Face Covering (score)	Color (score)	Outer-coat (score)
1955							
Group							
8	4	126.5	2.14	2.47	2.50	1.67	1.03
9	4	111.0	2.88	3.21	3.00	1.25	1.13
10	4	115.0	2.25	2.54	2.34	1.25	1.00
11	5	115.0	2.33	2.83	2.12	1.50	1.50
16	15	114.2	2.63	2.72	2.00	1.36	1.36
Total & Averages	32	116.3	2.44	2.75	2.39	1.40	1.20
1956							
Group							
8 & 9	3	106.0	2.72	2.78	2.61	1.67	2.44
10 & 11	3	105.0	2.55	3.00	1.56	1.00	1.61
16	13	102.0	2.77	2.95	1.92	1.43	1.41
Total & Averages	19	104.0	2.68	2.91	2.03	1.36	1.82
1955-56 Averages	51	110.0	2.56	2.83	2.21	1.38	1.51
1949-54 Averages	347	110.2	2.54	2.51	2.23	1.33	1.96

Body weights and scores of yearling coarsewool rams in Research Project 3 are summarized above. There has been little improvement in body weight over the five year average of 1949-54. The yearling body weights of 1955 were better than average. Most other traits are improved, with the exception of condition score, which was down in 1955-56, reflecting the lack of rainfall and poor range conditions.

FLEECE CHARACTERISTICS OF COARSEWOOL YEARLING RAMS

Year and Breeding Group No.	No. of Rams	Fiber Weights Grease (lbs.)	Fiber Weights Clean (lbs.)	Fiber Diameter (microns)	Grade *	Staple Length (cms.)	Other Med. Fibers (percent)
1955							
Group							
8	4	7.71	5.36	27.68	56s	13.0	0
9	4	6.99	4.46	25.00	60s	12.2	0
10	4	6.60	4.52	29.14	54s	12.5	0
11	5	7.07	4.47	27.21	56s	12.5	0
16	15	7.09	4.54	27.87	56s	12.4	0
Total & Averages	32	7.09	4.67	27.38	56s	12.5	0
1956							
Group							
8 & 9	3	7.88	5.06	25.98	58s	12.7	0.4
10 & 11	3	6.03	3.78	24.88	60s	13.6	0
16	13	6.61	4.00	23.57	62s	12.0	0
Total & Averages	19	6.84	4.28	24.81	60s	12.7	0.10
1955-56 Averages	51	6.97	4.47	26.09	58s	12.6	0.05
1949-54 Averages	350	7.37	4.86	28.10	56s	11.3	0.14

* Grade based on ASTM Standards.

The above table presents the fleece characteristics for the coarsewool yearling rams of Project 3. Yearling rams in both 1955 and 1956 were approximately equal in fleece traits. The 1956 rams were slightly finer in grade. Both groups were finer than the yearling rams of 1949-1954.

BODY WEIGHTS AND SCORES OF YEARLING COARSEWOOL EWES

Year and Breeding Group No.	No. of Ewes	Body Weight (lbs.)	Type (score)	Condition (score)	Face Covering (score)	Color (score)	Outer-coat (score)
1955							
Group							
8	7	78.3	2.97	3.01	1.88	1.43	2.19
9	5	80.2	2.54	2.65	1.53	1.20	1.87
10	7	77.6	3.07	3.31	1.48	1.00	2.60
11		No Ewes Saved in Group 11					
16	37	74.9	2.89	2.96	1.70	1.41	1.87
Total & Averages	56	77.7	2.86	2.98	1.64	1.26	2.13
1956							
Group							
8 & 9	4	85.8	2.34	2.67	1.67	1.25	1.50
10 & 11	2	84.0	2.25	2.25	2.00	3.50	1.25
16	10	73.0	2.55	2.82	1.60	1.30	1.75
Total & Averages	16	80.9	2.38	2.58	1.75	2.01	1.67
1955-56 Averages	72	79.3	2.62	2.78	1.69	1.63	1.90
1949-54 Averages	899	75.1	2.62	2.66	2.28	1.39	2.52

The above table summarizes body wieghts and scores of yearling coarsewool ewes. Both 1955 and 1956 body weights are above the 1949-54 averages. There is little difference among the scored traits, with the exception of face covering. There has been considerable gain in this trait. Outercoat scores are also much better than previous years. Of the two latter years, the coarsewool yearling ewes of 1956 appear to be the better.

FLEECE CHARACTERISTICS OF YEARLING COARSEWOOL EWES

Year and Breeding Group No.	No. of Ewes	Fleece Weights Grease (lbs.)	Fleece Weights Clean (lbs.)	Fiber Diameter (microns)	Fiber Traits at Side Grade *	Fiber Traits at Side Staple Length (cms.)	Fiber Traits at Side Other Med. Fibers (percent)
1955							
Group							
8	7	5.60	3.79	21.81	64s	12.7	0
9	5	5.46	3.28	23.57	62s	12.1	0
10	5	4.28	2.96	23.61	62s	12.1	0
11		None Saved in Group 11					
16	37	5.31	3.40	21.86	64s	12.4	0
Total & Averages	54	5.16	3.35	22.71	62s	12.3	0
1956							
Group							
8 & 9	4	5.68	3.55	23.03	64s	10.6	0
10 & 11	2	4.04	2.35	19.85	80s	9.2	0
16	11	4.90	2.87	22.04	64s	10.2	0
Total & Averages	17	4.87	2.93	21.64	64s	10.0	0
1955-56 Averages	71	5.01	3.14	22.17	64s	11.1	0
1949-54 Averages	899	5.80	3.50	24.70	60s	10.0	0.3

* Grade based on ASTM Standards.

The 1955 yearling coarsewool ewes were better in all traits than the 1956 group of similar ewes. The 1956 ewes graded slightly finer, but had a shorter staple length and lighter fleece weight. The 1955-56 average for all fleece characteristics is above the average for these traits of 1949 through 54. The fleece weights of 1955-56 are slightly smaller, but the clean yield is approximately two percent higher. Medullation has been nearly eliminated completely by constant selection against these undesirable fibers. The rigid selection practiced to obtain fleeces displaying good uniformity of grade, freedom from kemp, breediness, and medullation has resulted in a certain amount of selection pressure against staple length. Because of this, staple length has not gained as rapidly as would be possible otherwise. Kemp fibers have been so completely eliminated, it is no longer necessary to include data on kemp percentage in the fleece charateristics table.

RESEARCH PROJECT 4

INVESTIGATIONS OF WOOL FOR THE IMPROVEMENT OF NAVAJO, NAVAJO CROSSBRED, TARGHEE AND TARGHEE CROSSBRED SHEEP UNDER SOUTHWESTERN RANGE CONDITIONS.

The objective of this project is to investigate wool for the processing qualities, such as: fineness, uniformity, staple length, percent medullation, freedom from defects, and heavy clean fleece weights.

In the area of the Southwestern Range and Sheep Breeding Laboratory, the majority of sheep producers are Navajo Indians. A considerable portion of their income is derived from the sale of wool on the domestic market. In order to improve on the quality and quantity of the wools produced under these conditions, it is important to measure the traits of these wools and determine their relative values. Approximately tenppercent of the wool produced by the Navajo goes into hand manufacture of rugs, and the remaining ninety percent is sold on the domestic market. The physical properites of wool for these two uses vary. For weaving a coarse wool is necessary, but higher prices are received for the finer wool. The dsire to obtain more income has resutled in the intrduction of finer rams and in upgrading the original Navajo breed.

Since wool price is largely based on two factors, grade or fiber diameter, and percent yield, considerable effort is being made to study and improve these properties. In 1955 it was observed that wide yearling fluctuations have existed in fiber diameter measurements on yearling ewes. These fluctuations have occurred during years of rather severe drought conditions. The most difference has been in fiber diameter as measured by microns, rather than visual grade. Also, the yearly differences are greater in the coarsewool breeding groups than the fine-wool groups. The coarsewool group grades in a quarter-blood class in the best years, to a half-blood grade in the poorest. This represents a range of over 9 microns. Since considerable selection pressure is applied against coarse fleeces in some lines, it is apparent that yearly differences have some effect on fiber diameter.

To determine the effects of various factors on fiber diameter, the records of 750 yearling ewes were studied. These records were

taken during a five year period of 1950 through 1954. Years and breeding groups accounted for most of the total variation in fiber diameter. Ewes born of two-year-old mothers had significantly coarser fleeces than ewes born from three-toseven-year-old mothers or mothers of eight years of age or older. This difference is no doubt due to a genetic change, indicating that sheep in the flock are gradually getting coarser. Difference in fiber diameter due to birth and rearing was not significant. Fiber diameter followed the same trend as body weight and fleece weight. In years when these weights were greatest, the fiber diameter was the coarsest. The finewool groups did not vary as much between years as the coarsewool groups.

In a program designed for wool improvement, the measure of an animal's wool producing ability is of the utmost importance. An animal's value or rank would be determined by the amount of actual clean wool produced as an individual. The mount of clean wool produced is no doubt a function of the density of the fleece, the size of surface area, and length and fineness of fibers. To study the accuracy of predicting clean fleece weight, three methods were used in comparison to actual clean fleece weight determined by whole fleece scouring. These methods were: (1) a methods using multiple regression equations in which clean fleece weight was estimated from staple length, wool density, body weight and grease fleece weight; (2) scouring a small side sample and correcting the sample for residuals; (3) scouring a small sample uncorrected for residuals; and (4) scouring whole fleeces.

The multiple regression method appears to be as accurate and much less expensive than scouring small samples. The correction of smaples for residuals appears to be unnecessary if a careful scourin job is done. Mulitple regression equations gave a multiple correlation coefficiant (R) of 0.91. However, as shown by the multiple correlation coefficiant, very little information is lost if density or body weight or both are omitted. When staple length is omitted the (R) value drops from 0.91 to 0.82, and when grease fleece weight is omitted, the (R) value drops to 0.73. When both density and body weight are omitted, the (R) value only drops to 0.89.